National Aeronautics and Space Administration

NASAfacts

Fundamental Aeronautics Program

The Fundamental Aeronautics Program, part of NASA's Aeronautics Research Mission Directorate, explores cutting-edge solutions to enable radical new designs for vehicles that fly at all speeds from subsonic to hypersonic. Its researchers develop technologies and vehicle concepts to enable future versions of subsonic and supersonic vehicles that fly more cleanly, quietly and efficiently.

Fundamental Aeronautics addresses national challenges in air transportation and access to space:

- Public concerns over noise and emissions;
- Sustainability of affordable air travel despite increasing costs and the availability of jet fuel;
- Maintaining mobility within an airspace while meeting increasing demand; and
- Making meaningful progress toward faster means of transportation.

Potential outcomes that benefit the public and the nation include:

- Revolutionary airframe configurations;
- Dramatic decreases in noise, fuel consumption and greenhouse gas emissions;
- Improved air quality; and
- Improved propulsion systems.

Fundamental Aeronautics also supports NASA's human and robotic exploration missions by developing technologies and vehicle concepts for low-cost, reliable access to space, and for the entry, descent and landing of high mass payloads into the Martian and other planetary atmospheres.

Images (Clockwise, left to right) **Future Supersonic:** NASA wind tunnel tests of a Gulfstream Aerospace low-sonic-boom configuration assess the tools for designing aircraft that produce little or no sonic boom noise. **SMART Rotor:** NASA wind tunnel tests of the Smart Material Actuated Rotor Technology (SMART) assess helicopter blade active-control strategies for reducing vibrations and noise. **Scramjet Engine:** A hydrocarbon-fueled scramjet engine model was tested in a NASA wind tunnel able to simulate flight conditions from Mach 3 to 7. **Blended Wing Body:** Flight tests continue on a revolutionary aircraft design that smoothly blends an aircraft wing into a wide, tailless fuselage with top-mounted engines.

RESEARCH AREAS

Subsonic Fixed Wing Project

Researchers in this project develop concepts and technologies to enable dramatic improvements in noise, emissions and performance for subsonic and transonic aircraft while remaining economically viable. Advanced vehicle concepts like the hybrid wing body could accelerate improvements in subsonic fixed wing vehicles. New flight operations techniques such as extremely short takeoffs and landings could help accommodate increased air traffic without increasing environmental impact.

Major technical challenges include:

- Enabling major changes in engine cycle/airframe configurations;
- Reducing uncertainty in multidisciplinary design and analysis tools and processes;
- Testing and analyzing advanced multidiscipline-based concepts and technologies; and
- Conducting discipline-based foundational research.

Subsonic Rotary Wing Project

This project addresses barriers that keep rotary wing aircraft (helicopters and tilt rotors) from being used more widely in civil aviation, while keeping their unique capabilities. Potential benefits include increased speed and range, reduced noise levels and propagation, increased propulsion efficiency, increased payload capability and improved flight control systems.

Major technical challenges include:

- Highly complex, three-dimensional rotor and fuselage structures;
- Unsteady flows in speed regimes from low subsonic to high transonic;
- Dynamically stalled components;
- Harsh operating environments; and
- Highly loaded propulsion systems.

The Supersonics Project

Supersonics researchers work to eliminate barriers to the development and use of practical supersonic vehicles over land for both civilian and military aircraft in the Next Generation Air Transportation System.The project also explores the challenges of supersonic deceleration for Mars landings. Known as High Mass Mars Entry Systems, this effort uses NASA's aeronautics expertise to solve problems associated with flying vehicles into space and other planetary atmospheres.

Major technical challenges include:

- Weight and durability at high temperature;
- Airport noise, sonic boom and high-altitude emissions;
- Aero-propulso-servo-elastic analysis and design;
- Supersonic deceleration, including entry, descent and landing; and
- Computerized approaches to multidisciplinary design, analysis and optimization.

The Hypersonics Project

The severe heating effects caused by flying at hypersonic speeds—several thousands miles per hour—are especially challenging. Researchers for this project develop new technologies and concepts to enable air-breathing powered vehicles for access to space, and for safe, precise planetary entry, descent and landing of high-mass human and science missions.

Major technical challenges include:

- Airframe and propulsion materials able to withstand severe temperatures;
- Predictive models for compressible flow, turbulence, heating, ablation and combustion;
- Advanced hypersonics control techniques;
- Propulsion systems that integrate high-speed turbine engines and air-breathing scramjets; and
- Predictive computer modeling of structural interactions among airframe, inlet, nozzle and propulsion systems.

We're Working on...

Launching a two-stage vehicle concept with experimental payload to explore the operations, performance and stability of a simple hydrocarbon-fueled scramjet combustor

Reducing noise, nitrogen oxide emissions, fuel burn and takeoff gross weight for conventional "tube and wing" and unconventional aircraft architectures

Demonstrating through simulation a rotary wing vehicle flight control tool that enables control of a variable speed engine and transmission with no negative handling qualities

Conducting wind tunnel tests of models and developing software to help develop low-sonic-boom, low-drag aircraft designs

For more information about the Fundamental Aeronautics Program and NASA aeronautics research, visit **www.aeronautics.nasa.gov/fap/**.

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